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SUGARCANE VARIETY COMPOSITION IN PAKISTAN

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ABSTRACT

The national average cane yield in Pakistan is 48.8 t ha^{-1}, which is far below the yield potential of cane varieties. Mushroom spread of unapproved, undesirable, inferior quality discarded and disease susceptible sugarcane varieties is one of the major factors responsible for low per acre sugarcane yield in the country. Variety plays a fundamental key role both increasing and decreasing per unit-area sugarcane yield. Cultivation of good quality approved sugarcane varieties definitely improves yield, while use of unapproved inferior quality cane varieties effects sugarcane production negatively as situation prevails today. There are approximately more than 80 sugarcane varieties presently cultivated in the country. Amongst those, about 58% are such varieties, which are unapproved, inferior quality, mediocre and disease susceptible, and 42% are approved good qualities high yielding sugarcane varieties presently under cultivation across the country. The variety situation in Sindh is very much worse, where only 16% approved varieties are under cultivation and 84% varieties are of inferior quality, disease susceptible, undesirable and not recommended for the area. However, position both in Punjab and NWFP provinces is much better than that of Sindh. In Punjab, maximum area under sugarcane cultivation is with approved good quality cane varieties (56%) and 44% is under unapproved inferior quality cane varieties. Cane-variety composition in NWFP region is very much similar to Punjab.

Majority of the sugar mills have not yet realized the significance of good quality cane varieties, except a few. They are showing least concern in introducing approved high quality sugarcane varieties in their mill areas. Many sugar mills have high percentage of unapproved, inferior quality undesirable cane varieties in the area that negatively effect mill sugar recovery. Nevertheless, it is a appalling need of the time that sugar mill should either instigate collaboration with public research institutes to replacing unapproved, inferior quality, low sucrose and disease susceptible varieties with approved good quality cane varieties in their mill area or start research and development activities to develop their own good quality cane varieties; multiply the seed at their own farms or progressive farm and provide good quality seed to cane growers in their premises. This will help to improve variety composition in the mill area that will enhance sugar recovery of the mill on sustainable basis and consequently country sugar production. This may only be achieved through sincere collective efforts by all sugar mills and requires strong positive wills, determination and commitment by all stake holders. The National Coordinated Sugar Crops Research Program of the PARC can play a pivotal role to synchronize the efforts of all stakeholders to achieving sustainable self sufficiency in sugarcane production in the country.

INTRODUCTION

Sugarcane and sugar beet are two sugar crops grown in Pakistan. However, sugarcane is the main sugar crop, which provides major raw material for producing white sugar and "gur". Moreover, sugarcane contribution in value added agriculture and GDP is 3.4 percent and 0.7 percent, respectively. Besides sugar production, sugarcane also produces numerous valuable by-products like alcohol, used in pharmaceutical products; ethanol, used as a fuel; bagasse, used for paper and chip board manufacturing and co-generation, and press mad, used as a rich source of organic matter and nutrients for sustainable crop production.

Sugarcane was planted on acreage of about 0.91 million hectares with cane production of 44.3 million tons in Pakistan during the growing season of 2005-06. Punjab shared 69%, Sindh 20% and NWFP 11% of the total sugarcane area. Similarly, the shares of Punjab, Sindh and NWFP in total cane production are 65%, 25% and 10%, respectively (Fig.1). The national average-cane yield is 48.8 t ha', which is far below the existing potential of cane varieties under different agro-ecological zones of the country (Fig.2)

Yield potential of any commodity crop is defined as "Yield of a cultivar grown in an environment to which it is adapted, with nutrients and water non-limiting, and with pests and other stresses effectively controlled (Evans, 1981). In general, good crop growth and its yield result from the use of high yielding varieties with good crop management practices, such as use of adequate and balanced fertilizers (N, P, K and micronutrients), proper tillage, good quality seed, integrated pest management (IPM), proper and timely irrigation application, etc. These practices require more knowledge and education at the part of farmers, extension workers as well as sugar mills cane staff. To quote Borlang and Dowswell (1993) statement that "It is not sophisticated molecular genetics or biotechnology that are going to transform agricultural production in Asian countries over the next two decades, but rather more widespread and better application of improved existing technologies".

In Pakistan, there is great variation in per acre cane yield, which generally ranges from 30 to 250 t ha^{-1}. Many progressive farmers are getting maximum cane yield of 100 to 300 t ha^{-1} in the country. Thus, by cultivating good quality high yielding approved sugarcane varieties, along with all recommended management practices, a grower can get cane yield of 100 to150 t ha^{-1} in Punjab, 150 to 300 t ha^{-1} in Sindh and 100 to 120 t ha^{-1} in NWFP. Thus, Pakistan has a tremendous potential to raise its average sugarcane yield by more than 100% by cultivating good quality approved cane verities and adopting improved-production technology. Thus, the sincere efforts are needed to achieve the cane-yield potential rather than horizontal increase in sugarcane acreage. Under the prevailing and anticipated conditions of drought and water shortage, it is not possible as well as feasible to increase the acreage; rather it will be decreasing in the coming days.

Sugar industry in Pakistan is expanding rapidly without proper planning and feasibility studies. Currently, there are about 80 sugar mills in the country compared to 34 in 1980 and 02 in 1947. The present installed capacity of the sugar industry in Pakistan is approximately more than 6.0 million tons sugar production per annum against the existing sugar production of 2.6 million tons (2005-06). According to the reported data, the refined sugar production was 3.5 million tons during 1997–98 and 1998–99, 3.6 million tons in 2002–03, and 3.99 million tons in 2004–05 (Khan, 2005). Thus, almost, all sugar mills are running under capacity (50 – 60% of the capacity) due to low sugarcane production in the country, which

clearly reflects the scope of sugar crops research and development in Pakistan, which is presently very much lacking.

The government of Pakistan and sugar mills managements/owners, therefore, needs to give sincere attention to stop unplanned expansion of mills to secure the future of sugar industry in Pakistan and meet the country sugar requirements successfully. The present huge set up of sugar industry in the country is causing serious problem both for industry and cane growers. During the bumper crop season, farmers get lower cane price than the minimum support price fixed by the Government of Pakistan. Moreover, the sugar mills management also delays cane payments to growers. According to a study report, Rs. 2.5 Million was not paid to farmers during the past few years (Altaf, 2000). Similarly, involvement of middleman in the cane procurement system has further intensified these problems. The cane grower gets only 28% of the profit share and rest goes to the intermediary person and the mill management/owner (Altaf, 2000).

Reasons of low sugarcane productivity

Following are the major reasons of low sugarcane production in Pakistan.

- Weak variety development program
- Poor availability of improved variety seed.
- Mushroom cultivation of unapproved, inferior, discarded and disease susceptible varieties.
- Improper land selection
- Poor land preparation
- Low seed rate
- Use of conventional planting method
- Late Planting
- Poor plant protection measures
- Shortage of irrigation water
- Low and imbalance use of fertilizer
- Early and late harvesting
- Inadequate credit facilities to growers
- Poor farm mechanization
- Defective cane procurement system
- Unfriendly relationships between growers and mill managements/owners
- Climatic resistance
- Poor research in sugarcane technology
- Lack of agricultural education.

Variety plays a fundamental key role in sugarcane production. Cultivation of good quality approved high yielding cane varieties with improved crop-management practices can increase per acre cane yield. Unfortunately, we have mushroom spread of unapproved, inferior quality, discarded low yielding and disease susceptible varieties across the country, which have negative effect on national average per acre yield. Growers prefer to cultivate cane varieties, which are best suited to their own needs, give more return to them irrespective of quality. Under the prevailing procurement system they do not bother about the cane quality (sugar contents) but interested to grow cane varieties that have high tonnage (cane weight),

because of high return by weight payment basis. Farmers have question why to grow quality cane variety (low tonnage), when there is no difference in cane payment at the mill purchase point i.e. poor quality cane and good quality cane get the same price. This existing tendency results in mushroom cultivation of undesirable poor quality varieties on more and more area, which is highly detrimental to sugar industry and consequently to the country.

Weak variety-development program

Sugarcane research, particularly variety developed is handicapped due to unfavorable climatic conditions, inappropriate breeding facilities (cane fuzz or true seed production) and shortage of funds to run breeding research program effectively to meet the existing as well as future challenges of cane breeding/varietal development, cane agronomy and industrial research. In Pakistan, sugarcane flowers under natural conditions mainly in lower Sindh costal areas and slightly in Jabban Valley in Malakand Agency, NWFP. However, viable seed production under natural condition is a problem due to non-conducive climatic conditions of the area. The existing public sugarcane breeding programs in the country cannot fulfill the varietal requirements of the country because of non availability of required viable cane fuzz (true seed). The present varietal development program depends on the import of exotic cane setts and cane fuzz, which need heavy investment in foreign exchange, but the budget allocation for sugarcane research and development program is very poor.

Pakistan Agricultural Research Council (PARC) is playing an imperative role in sugar crops research and development program in the country. The National Coordinated Sugar Crops Research Program of the PARC has been doing collaborative research and development work with the public and private research institutes across the country for developing the potential sugarcane varieties and their improved production technology. The variety development program is mainly entrusted with exotic sugarcane setts and cane fuzz from major sugarcane growing countries of the world. Thus, despite afore- mentioned constraints, the National Coordinated Sugar Crops Research Program of the PARC has developed 23 sugarcane varieties through its provincial cooperative research programs and released for commercial cultivation in the country (Table- 1). Similarly, 20 sugarcane varieties developed through the above-mentioned variety development program are in pipeline (Table 2), which will be released soon for commercial cultivation after approval from the respective seed council and VEC. Unfortunately, although the good quality high yielding sugarcane varieties are available in the country, but their seed is not available to cane growers, especially small farmers, due to lack of development interest of the sugar mills in their respective areas. However, some sugar mills are taking interest and have high percentage of good quality sugarcane varieties in their mill areas, consequently high sugar recovery of the mill.

Sugarcane variety composition

i) **Country sugarcane-variety overview:**

Cane varieties play significant role in enhancing both cane and sugar yields. Unfortunately, at present, there is mushroom spread of unapproved, inferior quality discarded and disease susceptible sugarcane varieties in the country (Fig 3). There are 58% such sugarcane varieties presently cultivated in the country, which are unapproved, inferior quality, discarded, low yielding mediocre and disease susceptible, while 42% are those, which are approved, good quality, high yielding ones. The situation in Sindh is worse, there are only 16% approved

cane varieties presently cultivated in the whole Sindh, while 84% are not approved and inferior quality. However, situation in Punjab and Sindh are relatively better than Sindh. In Punjab, 56% cane varieties are approved and good quality, while 4% are unapproved inferior quality varieties under cultivation. Similarly, in NWFP 53% varieties grown by the farmers are approved and good quality, whereas 47% are those, which are unapproved and poor quality.

ii) Sugarcane Varieties Composition in Sindh:

Sugarcane area in Sindh is comprised of Upper, Central and Lower regions of the province. In the lower-Sindh area, cane variety situation is worse, as 97% sugarcane varieties under cultivation are unapproved and inferior quality (Table 3). Variety situation in the Central part of Sindh is relatively better, where 28% varieties are approved and good quality and 72% are inferior quality varieties. Similarly, in Upper Sindh, about 83% are poor quality and 17% are of good quality varieties.

Variety situation in the Dewan Sugar Mills, Dewan Khoshi Sugar Mills, Bawany Sugar Mills and Al-Asif Sugar Mills in the lower Sindh is very much discouraging, where more than 90% sugarcane area is under such varieties, which are unapproved and inferior quality, while only less than 4% area is under approved and good quality varieties (Table 4). In the central part of Sindh, the Mehran Sugar Mills made up 47% area under approved and good quality sugarcane varieties followed by Matiari Sugar Mills, which covers about 23% of total cane area under approved and good quality varieties and 76% under inferior quality varieties. Similarly, in the Upper Sindh, cane varieties situation in the Neudaro Sugar Mills is also not much encouraging, where area under approved good quality varieties is only 17%, while under unapproved varieties are 83% of total plant-cane acres in the area.

There are approximately more than 40 sugarcane varieties presently under cultivation in the Sindh province (Table 5); among those, only about 5 varieties are approved for the area and of good quality, while rest are not approved for the area and of inferior quality, discarded, low yielding and disease susceptible etc. The maximum area under cultivation of variety BL-4 (17.4%) followed by Triton (11.8%). The area under Indian varieties like Disco and CO-1148 are 0.9% and 0.1%, respectively mainly in the central and lower parts of the Sindh. Large numbers of unapproved and inferior quality varieties of cane are reported in the central part of the Sindh, where about 34 varieties are under cultivation. In the lower Sindh, BL-4 has maximum sugarcane area under its cultivation followed by Triton (31.5%); while in the central Sindh, the major area under cultivation is with variety CP-67/412 (18.5%) followed by NIA-98 (16.7%), SPSG-26 (13.3%) and HS-Thatta-10 (10.5%). However, in case of upper Sindh, the unapproved cane varieties “Chandka” occupied 25% and L-116 28% followed by approved cane variety of Gulabi-95 (9%) of total sugar cane area in the region.

Regarding the cane-variety situation in the sugar mills area; the Al-Asif Sugar Mills in lower Sindh has large area under Triton (47%) followed by BL-4 (33%) and BF-162 (12%) (Table 6). In the Bowani Sugar Mills area, Triton made up 53 percent sugarcane area followed by BL-4 (23%) and BF-162 (10%). Similarly, cane variety BL-4 has occupied 68% in the Khoshi Sugar Mills area followed by BF-129 (12%) and Triton (7%). However, the maximum area in the Dewan Farooq Sugar Mill, is again under variety BL-4 (48%) followed by Triton (18%), BF-129 (12%) and CP-43/33 (10%) in the lower Sindh.

In the Mehran Sugar Mill area in the Central Sindh, cane variety NIA-98 covers 47% area under its cultivation. The area under BL-4 in Mehran Sugar Mill is 16% followed by BF-162

(15%) and SPSG-26 (9%). In the Matiari Sugar Mill area, SPSG-26 covers maximum area of 30% followed by HS-Thatta 10 (17%). The area under CO-245 (Bansi) an unapproved cane variety is 12% followed by LRK-XA (10%). Similarly, in the Habib Sugar Mill area maximum sugarcane area is cultivated with variety CP-67/412 (48%) followed by cane variety HS-Thatta-10 (14%). Area under unapproved cane variety (HS-12), developed by the Habib Sugar Mill is 12% followed by Indian cane variety Disco (6%). However, in the upper Sindh, unapproved variety L-116 covers highest area of 28% followed by another unapproved cane variety "Chandka" (25%). In the Neudaro Sugar Mill area approved cane variety Gulabi-95 has occupied 9% area and LRK-2001cover 8% area.

iii) Cane-Variety Composition in Punjab:

There are more than 30 sugarcane varieties presently cultivated in the Punjab province; among those about 10 are approved and good quality varieties, while rest are unapproved, inferior quality, discarded and disease susceptible varieties. Sugarcane variety situation in the Northern area of Punjab is not high quality, where 62% sugarcane area is cultivated is with unapproved inferior quality and discarded varieties and 38% with approved good quality varieties (Table 3). In Central Punjab, cane-variety situation is comparatively better than northern region, where 61% sugarcane area is under approved good quality cane varieties, while 39% under unapproved inferior varieties. The cane-variety situation is relatively satisfactory in the South West region of Punjab, where 70% sugarcane area is cultivated with approved good quality varieties.

Cane-variety composition of the mill area in Punjab is presented in table- 4. In the Northern Punjab, 52% sugarcane area in the Shahtaj Sugar Mill is cultivated with approved god quality varieties and 48% with unapproved inferior quality varieties. In CSK Sugar Mill area, approved good quality varieties are cultivated on an area of 45% area, while 55% area is under inferior quality cane varieties. In the National Sugar Mill area, Sargodha, larger sugarcane acreage is with inferior quality cane varieties, which is 82% and only 18% with good quality cane varieties. In the Crescent Sugar Mill area, Faisalabad, cane-variety situation is very much similar to the National Sugar Mill area, where only 27% area is under good quality varieties and 73% area is under inferior quality varieties. However, variety situation in the Gojra-Summandri Sugar Mills and Habib Waqas Sugar Mills is relatively better as good quality cane varieties cover 66% and 62% total cane area and inferior quality varieties cover 34% and 38%, respectively. Variety situation in the Kamalia Sugar Mills area is much better than rest of the mills in the Central Punjab, where 86% sugar cane area is cultivated with approved good quality varieties and only 14% area with poor quality varieties. In the Shakarganj Sugar Mill, Jhang, area occupied by approved cane varieties is 58% and by unapproved inferior quality is 42%. However, varieties composition in the Layyah Sugar Mill area is very much acceptable, where 94% of the total sugarcane acreage is under approved good quality varieties, which is one of the best in the Punjab region and only 6% area is under inferior quality varieties. The situation in Fatima Sugar Mill in South Punjab is not very encouraging as area with poor quality varieties is 56% and with good quality 44%.

The maximum area under sugarcane cultivation in Punjab is with cane variety SPF-234, which is about 17% (Table 7) followed by inferior cane variety "Coj-84 (16%), locally called as "Kala India". The area under good quality cane variety "HSF-240" is 15% followed by another good quality variety CP-77/400 (11%) and inferior quality variety "SPF-238" (9%) locally called as "Richman" in Punjab. In Northern, Central and South West parts of Punjab, Indian variety "Co-1148" has occupied about 6% of total sugarcane area. There are about 15 sugarcane varieties cultivated in the Northern area of Punjab. The approved good quality cane

variety “CP-77/400” made-up largest area under its cultivation (21%) followed by inferior quality cane variety “Coj-84” (20%) in North of Punjab. Sugarcane area under another unapproved inferior variety “SPF-238” is 14% followed by another inferior variety “CO-975” (13%). An approved cane variety “HSF-240” covers only 12% area in Northern Punjab. In central parts of Punjab, about 27 sugarcane varieties are presently cultivated. The maximum cane area is covered by HSF-240 (19%) followed by SPF-234 (17%) and by inferior quality cane variety SPF-238 (14%). The variety CPF-237, which is another approved good quality cane variety covers only 8% area in the central Punjab followed by CP-77/400 (5%). The Indian variety “Co-1148” comprised of 4% area in Central Punjab. There are 20 sugarcane varieties cultivated in South West area of the Punjab. Variety SPF-234 is a leading variety in South West area of Punjab, which covers 34% sugarcane area in the Southern region followed by inferior quality cane variety Coj-84 (21%). The variety HSF-240 covers 13% area followed by CP-43/33, which covers 9% area in the South West part of Punjab.

In Shahtaj Sugar Mill, cane variety CP-77/400 occupies maximum 36% sugarcane area in Northern part of Punjab followed by SPF-238 (21%), an unapproved inferior quality variety and locally called as “Richman” (Table 8). The other inferior quality cane variety Co-975 covers 10% area followed by another inferior variety Coj-84 (9%) in the Shahtaj Sugar Mill area in Northern Punjab. Similarly, a Co-975 variety covers 28% sugarcane area in the CSK Sugar Mill, Phalia followed by CP-77/400 (22%) and HSF-240 (16%). Indian variety Co-1148 comprised of 3% and 2% sugarcane area in the CSK Sugar Mills and Shahtaj Sugar Mills, respectively. In the National Sugar Mill, Sargodha, cane variety Coj-84 covers 52% area followed by Co-1148, which made up of 15% area and followed by SPF-238 (10%). The area under approved cane varieties HSF-240, CP-77/400 and CPF-237 are 6%, 5.8% and 5%, respectively in the National Sugar Mill area Sargodha. In the Faisalabad District, maximum sugarcane area is planted with SPF-238 (60%) followed by HSF-240 (20%). The cane varieties SPF-213 and CPF-237 made up only 5% and 2% sugarcane area, respectively in the area. However, in the Gojra-Summandri, variety SPF-234 cultivated on an area of 37% followed by HSF-240 (15%). The inferior quality cane variety Coj-84 also covers 15% area followed by another inferior Indian variety Co-1148 (9%).

In Kamalia Sugar mills, the maximum sugarcane acreage is covered by SPF-234, which is about 41% followed by HSF-240 (17%). Cane variety “SPSG-394”, developed by Shakarganj. Sugar Mill covers 8% area in Kamalia Sugar Mill followed by CPF-237 (7%) and Co-1148 (6%). In the Habib Waqas Sugar Mill area, cane variety HSF-240 is cultivated on an area of 30% followed by CP-72/2086 (20%). An unapproved inferior quality cane variety SPF-241 occupied maximum area of 18% in the Habib Waqas Sugar Mill followed by HSF-240 and CPF-237 with 11% acreage each. In the Shakarganj Sugar Mill maximum number of 25 cane varieties are presently cultivated in the area. The maximum area under sugarcane cultivation is with an unapproved cane variety SPSG-79 (17%) followed by an approved cane variety HSF-240 (15%). Another good quality cane variety CPF-237 covers 12% sugarcane area in the Shakarganj Sugar Mill Jhang.

In Western region of Punjab, the Layyah Sugar Mill has maximum sugarcane cultivation with approved good quality cane varieties. Larger sugarcane area is covered with SPF-234 (35%) followed by CP-43/33 (19%). About 14% cane area is covered by cane variety CP-77/400 followed CPF-237 (5%). Area under Co-1148 is about 3%. In the Fatima Sugar Mill, cane variety Coj-84 cultivated on 41% area followed by SPF-234 (32%). The Indian variety Co-1148 covers 16% area in the Fatima Sugar Mill, followed by HSF-240 (10%). A good quality approved cane varieties; CP-77/400, CPF-237 and SPSG-26 are cultivated on an area of

1.2%, 1.0% and 0.4%, respectively in the Fatama Sugar Mill area in South part of the Punjab (Table 8).

iv) **Cane Variety Composition in NWFP**

Variety situation in NWFP province is comparatively better than Punjab and Sindh provinces. The ratio between approved good quality and unapproved inferior quality sugarcane varieties in NWFP is approximately equal (1:1). The NWFP region is categorized into Peshawar Valley and South West areas. Cane variety situation in the Peshawar Valley is much superior than South West area, as maximum area under sugarcane cultivation in Peshawar Valley is occupied by approved good quality cane varieties (68%), while in South West, only 37% area is covered by good quality varieties and 63% covered by unapproved inferior quality varieties (Table 3).

Cane variety situation in the Sugar Mill area of NWFP is presented in table 4. Cane- variety composition information indicated that ratio between approved good quality and unapproved inferior quality cane varieties in the Khazana Sugar Mill area, Peshawar is almost equal, where approved good quality varieties are cultivated on 52 % area and inferior quality on 48% area. In the Premier Sugar Mill area, Mardan, approved high quality varieties are cultivated on 68% area, while poor quality varieties cover 32% area. However, in the Frontier Sugar Mill area, cane variety situation is very much encouraging, where 87% sugarcane area is cultivated with approved high quality cane varieties and only 13% is under inferior quality varieties. The situation in South West of NWFP is very much discouraging. In Bannu Sugar Mill area, good quality cane verities covers 62% area, while 38% area comes under inferior quality varieties. The cane variety situation in Chasma Sugar Mill area is extremely discouraging, where 88% sugarcane area is cultivated with unapproved inferior quality cane varieties, while 12% cane varieties are of inferior quality.

There are about 30 sugarcane varieties presently cultivated in the NWFP province (Table 9). The area under good quality cane varieties CP-77/400 in NWFP is 21%, mainly in Peshawar Valley followed by inferior quality Indian variety Co-1148 (21%), which occupies major area in South West of the province. Cane variety “Bannu-I” made up 13% sugarcane area in NWFP, particularly in South West part of NWFP followed by CP-51/21 (6%) and CP-48/103 (4%), mainly in the Peshawar Valley. There are about 25 cane varieties presently cultivated in Peshawar Valley and 23 in South West area of NWFP. Cane variety CP-77/400 is cultivated on maximum area of 39% followed by CP-51/21 (10%) and CP-48/103 (7%) in the Peshawar Valley of NWFP. The Indian varieties Co-1148 and Coj-84 made up 4% and 3% sugarcane area, respectively in the Peshawar Valley. However, area under Indian variety Co-1148 in the South West part of NWFP is 38% followed by Bannu-I (25%). The cane variety Coj-84 covers 5% area followed by Triton (4%) and CP-77/400 (3%).

Cane variety composition of the Sugar Mill area NWFP is presented in table 10. This composition information shows that variety CP-77/400 is cultivated on 20% area followed by CP-51/21 (15 %) and CP-90 (10%) in the Khazana Sugar Mill (KSM) area, Peshawar. Indian variety covers 9% sugarcane area in the KSM area in Peshawar Valley and HS-Thatta-10 cane variety approved for Sindh area is also cultivated on 0.5% KSM area. In the Premier Sugar Mill (PRSM) area, CP-77/400 covers maximum area of 38% followed by CP-48/103 (18%) and NCO-310 (17%). Cane variety CP-44/101 is cultivated on 9% area of the PRSM in Peshawar Valley. In the Frontier Sugar Mill (FRSM) area, CP-77/400 covers largest area under its cultivation (58%) followed by Mardan-93 (8%) and CP-51/21 (8%). Indian variety Co-1148 is cultivated on 2% sugarcane area in the FRSM area. Cane variety Bannu-I is most

widely grown variety in the Bannu Sugar Mill (BNSM) area in South West part of NWFP followed by inferior quality Indian variety Co-1148 (15%). The other inferior quality variety Coj-84 covers 7% sugarcane area in the BNSM, Bannu, followed by Triton (5%). The maximum area is under inferior quality unapproved sugarcane variety "Co-1148", which is approximately 61% in the Chasma Sugar Mill area in South West of the NWFP followed by another unapproved cane variety CP-77/400 (4.3%).

Issues need special attention

i) Variety awareness

At present, more than 25 improved high qualities sugarcane varieties are available with different public research institutes for commercial cultivation across the country, which may certainly replace unapproved, inferior quality, mediocre and disease susceptible varieties in the area. However, this needs sincere efforts to create awareness among the cane growers about good quality approved cane varieties. The sugar mills management and agricultural extension department should take responsibility to creating awareness among the growers through field demonstration, electronic and print media etc.

ii) Availability of quality cane seed

Although, Public Research Institutes have basic seed of the good quality approved cane varieties at their research farms, but they cannot provide seed of these good quality varieties to all cane growers according to their needs, because Public Research Institutes have very limited resources and operational budget. Therefore, Sugar Mills should take lead to develop their own farms and multiply cane seed of approved varieties either at their own farm or at progressive growers farms in their respective area in collaboration with public research institutes under the supervision of cane breeder or agronomist and should supply good quality seed to farmers in the mill areas on subsidized rate.

iii) Growers interest

Only way to improve cane-variety composition in the country is to watch the interest of cane growers and ensure them their due respect they deserve. There is absolutely no doubt that a common cane grower wants to cultivate such cane varieties, which give him better yield and ultimately more return at minimum level of input cost. The inferior quality cane varieties requires less care with least input cost, but have returns more due to high cane weight as our present cane payment is based on tonnage basis instead of quality. Therefore, if cane payment system is changed from tonnage basis to variety quality premium basis and farmer is offered with incentive in terms of provision of inputs and extra subsidy on certain cane varieties, then he will definitely switch over to cultivate good quality cane varieties. High quality seed of good varieties and all types of necessary fertilizers may be provided to farmers, especially on interest free loan.

iv) Farmer's economic condition

Economic condition of majority of the cane growers is not good. They cannot afford to buy the recommended seed of good quality cane varieties, required quantity of fertilizer, insecticides and other crop inputs, necessary to maximize their per acre cane yield. Therefore, Sugar Mills should take it seriously and provide loan to farmers either without interest or on subsidized rate. They can also be incentivitized by providing crop inputs on subsidized rates.

v) Timely availability of inputs

Availability of quality crop inputs in the market at required crop stage at the affordable price is very much serious issue, which needs to be solved on top priority basis. The government should take it more seriously and ensure the availability of quality crop inputs in the market at reasonable price at required crop stage. This will certainly help the growers, especially small farmers to use crop inputs according to the recommendations made by the agricultural scientists or researchers or commodity experts.

vi) Water availability

Sugarcane crop requires high quantity of irrigation water, as it is a high delta crop. The summer months are the peak growth period for sugarcane. The water stress during these months drastically reduces cane yield and sugar recovery. Thus, keeping in view the prevailing water availability and anticipated water shortage situation in the country, it is highly important to reduce the area under sugarcane cultivation and should emphasized on vertical cane yield improvement through cultivation of drought tolerance good quality cane varieties. We should also look into the water saving or efficient water-use production technology. The Sugar Mills need to cooperate with Public Research Institutes to developing drought tolerance cane varieties and water saving crop management practices.

vii) Cane procurement system

The prevailing defective cane procurement system discourages cane growers to grow more sugarcane with good quality cane varieties, because of unjustified existing cane payment system and low cane support price. The growers have no incentive to grow good quality cane varieties. They get the same price, whether they cultivate inferior quality cane varieties or good quality high sucrose cane varieties.

viii) Relationship between growers and mill management/owners

The relationship between growers and mills managements/owners is presently not very much friendly. Many cane growers are shifting from sugarcane cultivation to other commodity crops because of unfriendly attitude of most of the sugar mills managements or owners. Timely payment to sugarcane growers for their produce is very important incentive to restore the trust of growers and encourage them to grow quality cane varieties. For delay in payment, mill should pay interest to growers according to the established rules of the financial institutes. System of payment at sugar mills office through cane procurement receipt (CPR) system should be changed by a cheque-payment system or farmer may draw his payment by presenting CPR in a local bank as a cheque. Similarly, farmers should not wait at mill gate for long days to dispose off their cane during the busy cane-harvesting days of the season.

ix) Unplanned sugar mills expansion

An expansion in sugar industry in the country is going on very rapidly and unplanned without proper feasibility study. There are already 80 Sugar Mills in the country and few more are expecting soon in the near future. Such huge unplanned set up of sugar factories is already causing serious problems both for growers and sugar industry. Almost all sugar mills are running under capacity approximately 50 to 60% of their crushing capacity and this causing cane shifting war between the sugar mills, especially during low cane production season as it happened in the recent past crop season (2005-06). This causes losses not only to mill owners, but also results into million rupees loss to the nation and consequently also causes reduction in sugar production in the country through cane stalling losses. Therefore, government needs to take appropriate action to stop further unplanned expansion of sugar industry in the country.

Future options and strategies

- There is a serious need to strengthening the existing public research institutes across the country by allocating more budget either funding from the cess funds or raising special funds by the Sugar Mills to developing new sugarcane varieties and improved crop-production techniques for better sugar cane production in the country. It will definitely help to securing better future of sugar industry in the country. Similarly, Sugar Research Institutions need to provide duly trained manpower almost in all subjects like sugar technology breeding, agronomy, pathology, entomology and sugarcane engineering etc.
- New good quality cane varieties and improved crop production techniques, developed by the Public Research Institutes can only be utilized and farmers be benefited, if the cane growers are motivated to practice or adopt them effectively. Farmers may be motivated either by providing better cane procurement system by pursuing the cane development program in the mill area on regular basis through collaborative efforts by all Sugar Mills or by restoring the trust between the cane growers and Sugar Mills managements or owners.
- Otherwise, Sugar Mills should develop their research farm and start research and development activities by hiring agricultural graduates and develop their own high quality sugarcane varieties and crop production technology. This is the only viable option for Sugar Mills to run their sugar factory smoothly and profitably on sustainable basis in the coming days, when there will be high competition among the mills because of unplanned huge set of the sugar industry in the country.
- Sugar mill should multiply good quality cane seed at their own farms or at progressive farms in collaboration with Public Research Institutes under the supervision of cane breeder or agronomist and then provide this seed to farmers, especially to small farmers in their mill areas.
- Sugar mills should arrange field days and farmer meetings at planting and harvesting times by inviting private companies, government and private sugarcane experts. The National Coordinated Sugar Crops Research Program of the PARC can play central role to organize such activities in collaboration with sugar mills in country.
- Cane varietal performance need to be critically examined by the unbiased multidisciplinary team before its release for commercial cultivation in the country. The role of National Coordinator of Sugar Crops Research Program of the PARC need to be highlighted in the variety approving process and each provincial seed department should involve the National Coordinator in variety approval process. It will definitely help to develop promising good quality high yielding long-lasting sugarcane varieties.
- Federal and provincial cane commissioners need to take necessary measures to bane cultivation of unapproved inferior quality cane varieties in all the provinces. Sugar mills management should cooperate with government machinery to stop cultivation of unapproved inferior quality cane varieties in the country.
- Cane growers should be discouraged to cultivating unapproved inferior quality, discarded, diseased, susceptible and low sucrose content cane varieties. They should be encouraged to plant approved good quality high sucrose content varieties through attractive ingenious package made by sugar mills for growers, especially the small farmers.

ACKNOWLEDGEMENT

Sincere help of Mr. Abdul Waheed Qureshi, President of Pakistan Society of Sugar Technologist and Sugar Mills managements, who supplied the cane-variety data information to furnish this technical paper and present at the seminar on "Development of Sugarcane in Punjab" with specific reference to improvement in the varietal composition" held on June 19, 2006 in Naqqush Hall, Serena Hotel, Faisalabad, is gratefully acknowledged.

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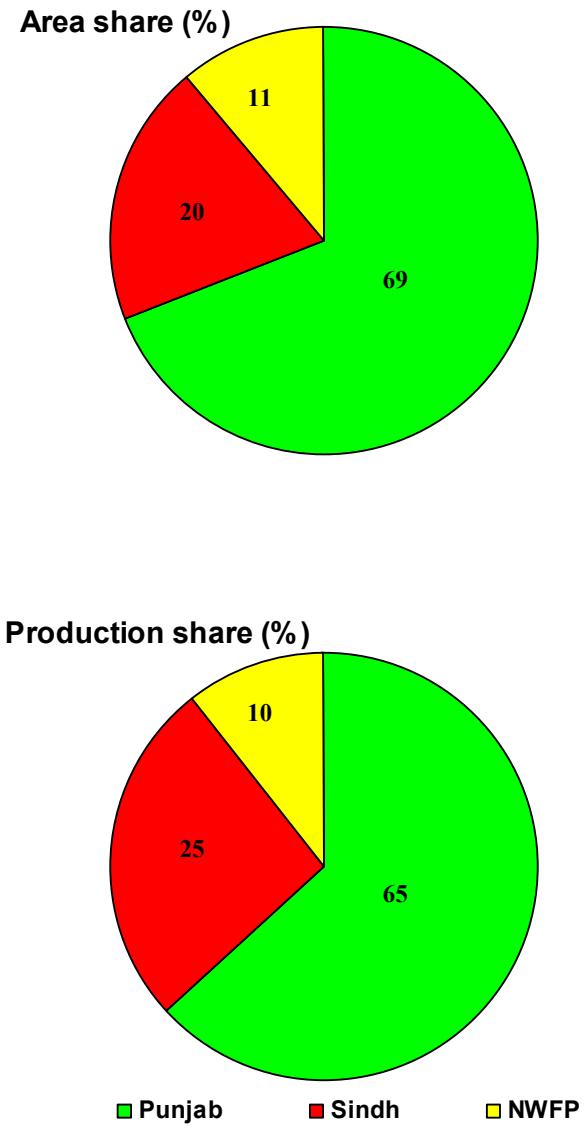

Fig. 1: Provincial share in sugarcane area and production during 2005-06

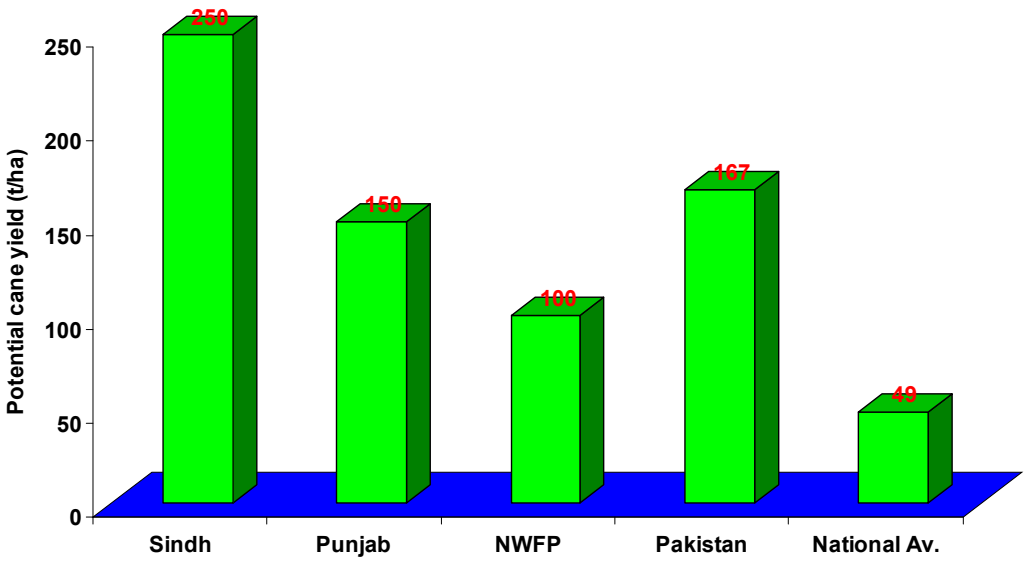

Fig. 2: National average vs potential per hectare yields of sugarcane in Pakistan

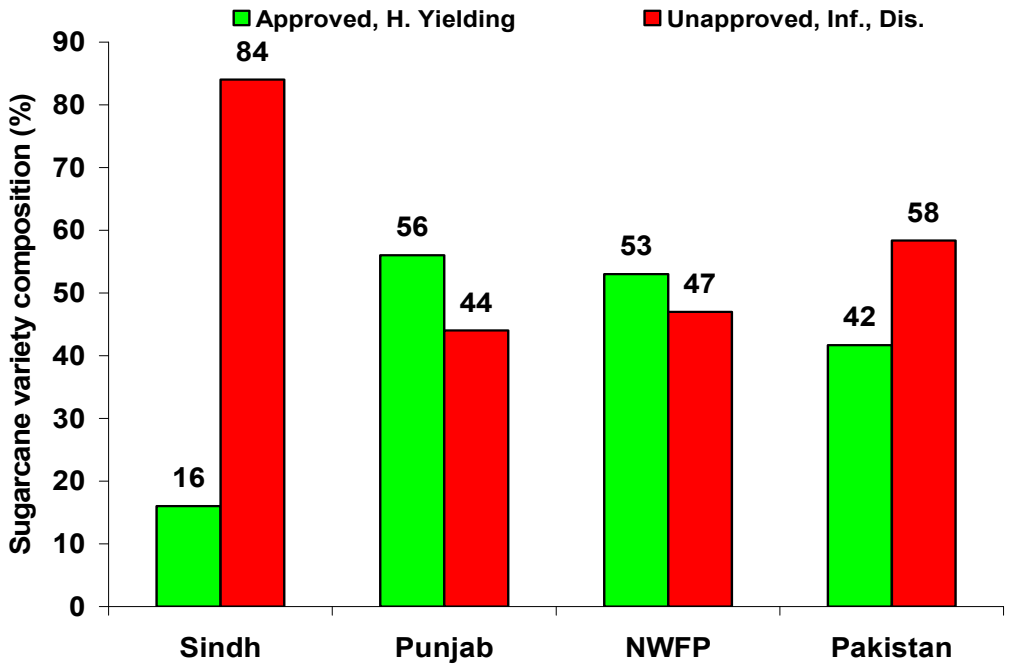

Fig. 3: Present overall sugarcane-varieties situation in Pakistan

Table-1 High yielding commercial sugarcane varieties developed and released through National Coordinated Sugar Crops of the PARC

Variety	Year of release	Maturity	Cane yield (t ha^{-1})	Sugar content (%)
For Punjab				
SPSG-26	1996	Early	98	10.5
CP-43-33	1996	Early	80	11.7
CP-77-400	1996	Early	90	11.9
SPSG-394	2000	Early	110	11.5
CPF-237	2000	Early	95	12.5
SPF-213	2000	Mid	100	11.0
HSF-240	2002	Early	95	11.7
SPF-234	2002	Early	100	11.6
SPF-245	2004	Early	100	11.0
HSF-242	2006	Early	108	12.4
For Sindh				
Ghulabi-95	1995	Early	150	11.0
NIA-98	1998	Mid	180	10.5
HSThatta-10	2004	Early	180	11.0
NIA-2004	2004	Mid	104	08.5
LRK-2001	2005	Early	200	11.0
For NWFP				
Mardan-92	1992	Mid	100	12.0
Mardan –93	1993	Early	100	12.5
CP-77-400	1996	Early	80	12.7
Jn-88/1	1996	Early	70	12.7
Abid-96	1996	Early	70	12.5
SN-98	1998	Early	72	12.2
MCP-421	2003	Mid	80	12.5
Mardan-2005	2005	Early	90	12.2

Table-2 Pipeline high yielding sugarcane varieties developed through National Coordinated Sugar Crops Research Program of the PARC

Variety	Maturity	Cane Yield (t ha^{-1})	Sugar Recovery (%)
For Punjab			
CPF-243	Early	102	12.7
SPF-241	Early	130	11.5
SPF-244	Early	120	11.3
NSG-6	Early	114	10.8
NSG-311	Early	117	11.3
NSG-555	Early	129	10.7
CSSG-668	Early	119	10.1
CSSG-676	Early	108	10.3
For Sindh			
HoTh-127	Early	180	11.0
HoTh-326	Early	200	11.0
LRK-2003	Early	150	12.0
LRK-2004	Early	150	11.0
Chandka	Mid	150	11.0
GanjBakhsh	Early	150	11.0
For NWFP			
CP-83-1491	Early	103	13.7
CP-80-1827	Early	97	13.1
CP-87-1628	Early	101	13.7
MS-91-CP-582	Early	94	13.2

Table-3 Area-wise provincial cane-variety overview

Variety Status	Variety Composition (%)			
In NWFP				
	Peshawar valley	**South West Area**	**NWFP**	
Approved, H. yielding	68.1	36.6	52.5	
Unapproved, inferior quality	31.9	63.4	47.5	
In Punjab				
	Northern Area	**Central Area**	**South West**	**Punjab**
Approved, H. yielding	38.3	60.8	69.1	56.1
Unapproved, inferior quality	61.7	39.2	30.9	43.9
In Sindh				
	Upper Sindh	**Central Sindh**	**Lower Sindh**	
Approved, H. yielding	17.0	28.4	02.6	
Unapproved, inferior quality	83.0	71.6	97.4	

Table 4: Sugarcane-variety situation in mill area of the provinces

Variety Status	Variety Composition (%)									
	Name of Mills									
In NWFP	**KHSM Pesahwar**		**PRSM Mardan**		**FRSM T.B. Mardan**		**BNSM Bannu**		**CHSM D.I. Khan**	
Approved, H. yielding	49.7		68.0		87.0		62.1		11.8	
Unapproved, inferior quality	50.3		32.0		13.0		37.9		88.2	
In Punjab	STSM M.B	CSKSM Phalia	NASM Sargodha	CRSM F.abad	GSSM Gojra	KMSM Kamalia	HWSM S. Pura	SGSM Jhang	LYSM Layyah	FTSM K. Adu
Approved, H. yielding	51.8	45.2	17.8	26.9	66.4	85.9	62.0	58.0	94.1	44.0
Unapproved, inferior quality	48.2	54.8	82.2	73.1	33.6	14.1	38.0	42.0	05.9	56.0
In Sindh	NDSM Larkana	HBSM N. Shah	MTSM Matiari	MHSM T.A. Yar	DFSM BT Thatta	KHSM Khoski	BASM Badin		ASSM Garo	
Approved, H. yielding	17.0	14.0	23.5	47.5	03.0	03.0	04.2		01.0	
Unapproved, inferior quality	83.0	86.0	76.5	52.5	97.0	97.0	95.8		99.0	

Note: KHSM, Khazana Sugar Mills Ltd.; PRSM, Premier Sugar Mills Ltd.; FRSM, Frontier Sugar Mills Ltd.; BNSM, Bannu Sugar Mills Ltd.; CHSM, Chashma Sugar Mills Ltd.; STSM, Shahtaj Sugar Mills Ltd.; CSKSM, CSK Sugar Mills Ltd.; NASM, National Sugar Mills Ltd.; CRSM, Crescent Sugar Mills Ltd.; GSSM, Gojra Samundri Sugar Mills Ltd.; KMSM, Kamalia Sugar Mills Ltd.; HWSM, Habib Waqas Sugar Mills Ltd.; SGSM, Shakarganj Sugar Mills Ltd.; LYSM, Layyah Sugar Mills Ltd.; FTSM, Fatima Sugar Mills Ltd.; NDSM, Naudero Sugar Mills Ltd.; HBSM, Habib Sugar Mills Ltd.; MTSM, Matiari Sugar Mills Ltd.; MHSM, Mehran Sugar Mills Ltd.; DFSM, Sugar Mills Ltd.; KHSM, Khoshki Sugar Mills Ltd.; BASM, Bawani Sugar Mills Ltd.; ASSM, Al-Asif Sugar Mills Ltd.

Table-5 Sugarcane-variety situation in the Sindh region

Composition (%)				
Variety	**Upper Sindh**	**Central Sindh**	**Lower Sindh**	**Sindh**
Gulabi-95	9.0	1.2	-	3.4
NIA-98	-	16.7	-	5.6
NIA-2004	-	0.1	-	0.03
LRK-2001	8.0	-	-	2.7
HSThatta -10	-	10.5	2.6	4.3
LRK-2004	3.0	-	-	1.0
SPF-237	-	0.3	-	0.1
SPF-234	5.0	0.3	-	1.8
CPF-213	-	0.1	-	0.03
BL-19	1.0	-	-	0.3
CP-73/75	-	0.1	-	0.03
BL-4	3.0	6.1	43.1	17.4
SPF-245	-	0.1	-	0.03
L-116	28.0	1.3	0.5	9.9
Triton	-	4.0	31.5	11.8
Ganj Baksh	10.0	-	-	3.3
CP-20/7284	-	0.7	0.4	0.4
Chandka	25.0	-	-	8.3
LRK-2003	8.0	-	-	2.7
LRK-XA	-	3.2	0.2	1.1
L-113	-	0.5	-	0.2
CP-43/33	-	1.7	2.7	1.4
CO-245 (Bansi)	-	4.3	0.6	1.7
L-126	-	0.8	-	0.3
BF-162	-	6.1	-	2.0
BF-129	-	2.1	10.1	4.1
PR-1000	-	0.4	5.2	1.9
HS-4	-	0.2	-	0.1
CP-77/400	-	0.1	0.5	0.2
SPSG-26	-	13.3	0.7	4.7
SPSG-394	-	0.1	-	0.03
HS-2	-	1.0	1.1	0.7
HS-12	-	5.0	-	1.7
HSF-242	-	0.1	-	0.03
HSF-240	-	0.1	-	0.03
SPF-234	-	0.1	0.7	0.3
CP-67/412	-	18.5	-	6.2
MK-7	-	0.2	-	0.1
Disco (B-43/60)	-	2.0	0.6	0.9
Co-1148	-	0.2	-	0.1

Table-6 Cane-variety composition in the mill area of Sindh province

Composition (%)								
	Upper Sindh	Central Sindh			Lower Sindh			
Variety	**NDSM**	**HBSM**	**MTSM**	**MHSM**	**DFSM**	**KHSM**	**BASM**	**ASSM**
Gulabi-95	9.0	-	3.5	-	-	-	-	-
NIA-98	-	-	2.7	47.3	-	-	-	-
NIA-2004	-	-	-	0.1	-	-	-	-
LRK-2001	8.0	-	-	-	-	-	-	-
HSThatta-10	-	14.0	17.3	0.1	3.0	3.0	4.2	0.1
LRK-2004	3.0	-	-	-	-	-	-	-
SPF-237	-	-	-	0.8	-	-	-	-
SPF-234	5.0	-	-	0.9	-	-	-	-
CPF-213	-	-	-	0.1	-	-	-	-
BL-19	1.0	-	-	-	-	-	-	-
CP-73/75	-	-	-	0.1	-	-	-	-
BL-4	3.0	0.8	1.6	15.9	48.0	68.0	23.2	33.3
SPF-245	-	-	-	0.1	-	-	-	-
L-116	28.0	1.6	1.4	0.9	-	-	2.1	-
Triton	-	0.5	7.7	3.7	18.0	7.6	53.3	47.0
Ganj Baksh	10.0	-	-	-	-	-	-	-
CP-20/7284	-	-	-	2.0	-	-	-	1.7
Chandka	25.0	-	-	0.1	-	-	-	-
LRK-2003	8.0	-	-	-	-	-	-	-
LRK-XA	-	-	9.6	-	-	-	-	0.9
L-113	-	1.5	-	-	-	-	-	-
CP-43/33	-	5.0	-	-	10.0	0.6	-	-
Co-245 (Bansi)	-	-	12.0	1.0	1.0	-	1.5	-
L-126	-	0.2	2.1	-	-	-	-	-
BF-162	-	3.0	-	15.3	-	-	-	-
BF-129	-	2.0	4.4	-	12.0	6.2	9.9	12.3
PR-1000	-	-	1.3	-	2.0	12.0	3.9	2.9
HS-4	-	0.3	-	0.4	-	-	-	-
CP-77/400	-	-	-	0.2	1.0	1.0	-	-
SPSG-26	-	0.3	30.2	9.3	1.0	0.4	0.8	0.7
SPSG-394	-	0.2	-	-	-	-	-	-
HS-2	-	3.0	-	-	3.0	-	0.2	1.2
HS-12	-	12.0	-	2.9	-	-	-	-
HSF-242	-	-	-	0.1	-	-	-	-
HSF-240	-	0.2	-	0.2	-	-	-	-
SPF-234	-	0.2	-	-	1.0	0.2	0.9	0.7
CP-67/412	-	48.0	7.5	-	-	-	-	-
MK-7	-	0.5	-	-	-	-	-	-
Disco (B-43/60)	-	6.0	-	-	1.0	1.0	0.3	0.2
Co-1148	-	0.7	-	-	-	-	-	-

Note: NDSM, Naudero Sugar Mills Ltd.; HBSM, Habib Sugar Mills Ltd.; MTSM, Matiari Sugar Mills Ltd.; MHSM, Mehran Sugar Mills Ltd.; DFSM, Sugar Mills Ltd.; KHSM, Khoshki Sugar Mills Ltd.; BASM, Bawani Sugar Mills Ltd.; ASSM, Al-Asif Sugar Mills Ltd.

Table-7 Cane-variety situation in Punjab region

Composition (%)				
Variety	**Northern Area**	**Central Area**	**Southern Area**	**Punjab**
SPSG-26	-	2.4	0.3	0.9
SPSG-394	-	1.5	0.1	0.5
CP-43/33	-	1.4	9.4	3.6
CP-72/2086	0.5	4.2	0.1	1.6
CP-77/400	21.1	5.1	7.5	11.2
CPF-237	5.1	7.5	2.8	5.1
SPF-213	0.7	2.6	0.6	1.3
HSF-240	11.6	19.4	12.6	14.5
SPF-234	-	16.6	33.4	16.7
SPF-245	-	0.2	-	0.1
HSF-242	0.3	4.4	2.4	2.4
SPF-220	3.5	-	0.1	1.2
SPF-238 (Richman)	14.1	13.6	-	9.2
SPF-241	2.7	5.0	-	2.6
SPF-236	-	0.1	0.1	0.06
LCP-81/10	0.3	-	0.1	0.1
Triton	-	0.2	-	0.1
L-118	-	0.1	-	0.03
BF-162	-	0.5	-	0.2
Co-975	12.8	0.2	-	4.3
Coj-84 (Kala India)	20.7	4.7	20.8	15.4
Co-1148	6.5	3.8	9.3	6.5
NSG-60	-	0.1	0.2	0.1
NSG-311	-	0.2	-	0.1
NSG-6	-	0.1	-	0.03
NSG-555	-	0.5	0.1	0.2
SPSG-79	-	4.2	0.2	1.5
Jeff-4, 6	0.7	-	-	0.2
CP-76-611	-	1.8	0.2	0.6

Variety	STSM (MB)	CSKSM (Phalia)	NASM SGD	FSD Area	GSSM Gojra	KMSM Kmalia	HWSM Nankana	SGSM (Jhang)	LYSM Layyah	FTSM K.Addu
SPSG-26	0.01	-	-	0.4	1.8	1.8	-	7.9	0.2	0.4
SPSG-394	-	-	-	-	-	7.7	-	-	0.1	-
CP-43/33	0.1	-	0.03	-	2.7	1.8	-	2.6	18.7	-
CP-72/2086	0.4	1.2	-	-	-	-	20.0	1.1	0.1	-
CP-77/400	35.5	22.0	5.8	0.6	3.8	5.2	10.0	6.1	13.8	1.2
CPF-237	5.2	5.0	5.0	2.0	5.7	7.3	11.0	11.4	4.5	1.0
SPF-213	-	2.0	-	5.0	-	2.2	-	5.8	1.2	-
HSF-240	12.5	16.0	6.4	20.0	14.9	16.7	30.0	15.3	15.4	9.8
SPF-234	-	-	-	0.5	36.5	40.9	-	5.2	35.3	31.5
SPF-245	-	-	-	1.0	-	-	-	-	-	-
HSF-242	0.2	0.2	0.5	2.0	1.9	2.7	11.0	4.3	4.6	0.2
SPF-220	3.0	7.4	-	-	-	-	-	-	0.2	-
SPF-238 (Richman)	20.6	11.5	10.2	60.0	4.3	1.4	-	2.1	-	-
SPF-241	0.4	3.0	4.7	5.0	0.9	-	18.0	1.1	-	-
SPF-236	-	-	-	-	0.3	-	-	0.1	0.1	-
LCP-81/10	0.5	0.3	-	-	-	-	-	-	0.1	-
Triton	-	-	-	-	-	-	-	1.2	-	-
L-118	-	-	-	-	-	-	-	0.2	-	-
BF-162	-	-	-	-	-	0.9	-	1.5	-	-
Co-975	10.3	28.0	-	-	-	-	-	0.9	-	-
Coj-84 (Kala India)	8.8	1.0	52.3	2.0	15.2	4.8	-	1.8	1.1	40.5
Co-1148	2.0	2.4	15.0	0.6	8.7	6.1	-	3.8	3.1	15.5
NSG-60	-	-	-	-	-	-	-	0.4	0.4	-
NSG-311	0.1	-	-	-	-	-	-	0.9	-	-
NSG-6	-	-	-	-	-	-	-	0.5	-	-
NSG-555	0.1	-	-	0.7	-	0.9	-	1.1	0.1	-
SPSG-79	-	-	-	-	4.2	-	-	17.0	0.4	-
Jeff-4, 6	0.8	0.1	-	-	-	-	-	-	-	-
CP-76-611	-	-	-	-	-	-	-	8.9	0.3	-

Note: STSM, Shahtaj Sugar Mills Ltd.; CSKSM, CSK Sugar Mills Ltd.; NASM, National Sugar Mills Ltd.; CRSM, Crescent Sugar Mills Ltd.; GSSM, Gojra Samundri Sugar Mills Ltd.; KMSM, Kamalia Sugar Mills Ltd.; HWSM, Habib Waqas Sugar Mills Ltd.; SGSM, Shakarganj Sugar Mills Ltd.; LYSM, Layyah Sugar Mills Ltd.; FTSM, Fatima Sugar Mills Ltd.

Table-9 Sugarane variety situation in NWFP region

	Composition (%)		
Variety	**Peshawar valley**	**Southern West**	**NWFP**
Mardan-92	3.1	1.0	2.1
Mardan-93	4.8	1.5	3.2
CP-77/400	38.8	3.1	21.0
BF-129	-	1.0	0.5
JN-88/1	0.3	-	0.2
CP-83/53	0.9	1.0	0.9
SPF-234	-	2.1	1.1
HSF-240	0.6	2.7	1.6
MCP-421	1.5	-	0.8
Mardan-2005	2.0	1.2	1.6
SPSG-79	0.9	2.4	1.6
SPSG-394	2.0	1.2	1.6
HSF-242	-	0.3	0.1
CP-51/21	10.4	2.5	6.4
CP-48/103	6.9	1.9	4.4
CP-65/357	1.7	2.9	2.3
CP-44/101	4.4	-	2.2
CPM-13	0.7	-	0.3
BL-4	-	0.2	0.1
Co-1321	0.4	1.0	0.7
L-62/96	0.2	1.0	0.6
Co-1148	4.2	37.9	21.0
Coj-84	2.6	5.1	3.9
BANNU-1	-	25.0	12.5
SPF-213	-	0.4	0.2
CP-90	3.2	-	1.6
Thatta-10	0.2	-	0.1
NCO-310	8.1	-	4.0
CPF-237	2.0	1.2	1.6
Triton	0.7	4.0	2.4

Table-10 Sugarcane-variety composition in the mill area of NWFP

Composition (%)					
	Peshawar valley			Southern West	
Variety Name	**KHSM Peshawar**	**PRSM Mardan**	**FRSM TB Mardan**	**BNSM Bannu**	**CHSM D. I. Khan**
Mardan-92	4.0	0.4	5.0	-	2.0
Mardan-93	3.7	2.8	8.0	3.0	-
CP-77/400	20.0	38.4	58.0	1.9	4.3
BF-129	-	-	-	-	2.0
JN-88/1	-	0.5	0.5	-	-
CP-83/53	2.7	-	-	1.3	0.6
SPF-234	-	-	-	-	4.2
HSF-240	1.7	-	-	1.3	4.0
MCP-421	2.9	0.1	1.5	-	-
Mardan-2005	2.0	-	4.0	-	2.3
SPSG-79	2.7	-	-	1.6	3.1
SPSG-394	1.0	0.1	5.0	-	2.3
HSF-242	-	-	-	-	0.5
CP-51/21	15.0	8.1	8.0	2.9	2.0
CP-48/103	-	18.4	2.4	3.2	0.5
CP-65/357	2.3	0.9	1.8	3.7	2.0
CP-44/101	2.1	9.3	1.9	-	-
CPM-13	1.9	-	0.1	-	-
BL-4	-	-	-	-	0.4
Co-1321	-	-	1.1	2.0	-
L-62/96	0.1	-	0.5	2.0	-
Co-1148	9.3	1.2	2.0	15.0	60.7
Coj-84	7.9	-	-	7.3	2.9
BANNU-1	-	-	-	50.0	-
SPF-213	-	-	-	-	0.8
CP-90	9.7	-	-	-	-
Thatta-10	0.5	-	-	-	-
NCO-310	7.1	17.1	-	-	
CPF-237	2.3	3.1	0.5	-	2.3
Triton	1.7	0.3	0.1	5.0	3.0

Note: KHSM, Khazana Sugar Mills Ltd.; PRSM, Premier Sugar Mills Ltd.; FRSM, Frontier Sugar Mills Ltd.; BNSM, Bannu Sugar Mills Ltd.; CHSM, Chashma Sugar Mills Ltd.

EFFECT OF DIFFERENT NPK LEVELS ON CANE AND SUGAR PRODUCTION OF SUGARCANE VARIETY GULABI-95

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ABSTRACT

In order to investigate the effect of NPK levels on cane yield and recovery of sugarcane variety Gulabi-95, an experiment was conducted at Sugarcane Section, A.R.I. Tandojam during 2004-2005. Treatments included T1=Control, T2=175-92-117 kg, T3=200-102-142 kg, T4=225-112-168 kg and T5=250-122-193 kg NPK ha^{-1}. The results revealed that all the growth, cane yield and sugar recovery contributing characters were affected significantly due to increasing levels of NPK fertilizers except germination, which remained unaffected. Higher NPK level of 250-122-193 kg ha^{-1} produced significantly greater values for all the characters studied, where germination was 53.53%, cane length 2.20 m, cane girth 2.49 cm, tillers 6.58 $stool^{-1}$, 10 canes weight 14.20 kg, cane yield 115.264 t ha^{-1}, brix 22.02 % and sugar recovery 10.72 %. The NPK level of 225-112-168 kg NPK ha^{-1} produced germination 51.06%, cane length 2.16 m, cane girth 2.49 cm, tillers 6.35 $stool^{-1}$, 10 canes weight 13.95 kg, cane yield 113.461 t ha^{-1}, brix 21.74 % and sugar recovery 10.66 %. There was an inverse trend of effectiveness for all the quantity and quality parameters with decrease in NPK fertilizer levels. It was concluded that Gulabi-95 responded maximally to 250-122-193 kg NPK ha^{-1} level, however, the differences were non-significant when compared with 225-112-168 kg NPK ha^{-1} levels. Hence, 225-112-168 kg NPK ha^{-1} fertilizer level was considered as an optimum level for economical cane and sugar production in variety Gulabi-95.

Key Words: Sugarcane, Nitrogen, Phosphorus, Potassium, Gulabi-95, Yield, Brix, Recovery.

INTRODUCTION

Sugarcane (*Saccharum*) is a genus of between 6–37 species (depending on taxonomic interpretation) of tall grasses (family Poaceae, tribe Andropogoneae), native to warm temperate to tropical regions of the Old World. They have stout, jointed fibrous stalks 2–6 m tall and sap rich in sugar. All the species interbreed, and the major commercial cultivars are complex hybrids. About 107 countries grow the crop to produce 1,324 million tonnes (more than 6 times the amount of sugarbeet produced). The largest producers are Brazil, India, and China, accounting for more than 50% of world production. It is also one of the main cash crops of Pakistan, where it is grown on commercial scales in three provinces i.e. Punjab, Sindh and NWFP, while the climate of Balochistan is not suitable for sugarcane cultivation (Vikipedia, 2006).

Sugarcane is a major cash crop of Pakistan as well as of Sindh province. At present, there are 31 Sugar Mills in function in the province of Sindh. The sugarcane was cultivated on an area of 214.9 thousand hectares in Sindh province, producing 11263.8 thousand tones of cane with an average yield of 52.5 tonnes per hectare during 2004-05 (Anonymous, 2006). The situation was

not promising comparing the figures of last year (2003-2004) when sugarcane was cultivated on an area of 259.9 hectares, producing 14611.8 thousand tones of cane with an average yield of 56.2 tonnes per hectare (GOP, 2005). As per statistics, sugarcane has been sown in an area of 0.900 million hectares, the 5.8 percent below the target and 6.8 per cent less than last year. Sugarcane production for the year 2005-06 is estimated at 40.1 million tons against the original target of 50.095 million tons and last year's achievement of 47.244 million tons. Thus, sugarcane production is estimated to be lower by 15.1 per cent over the last year. Factors responsible for the decline in sugarcane production include late harvesting of wheat and farmers shifting to other competing crops (Ali, 2006).

The cane yield and sugar recovery obtained in our country is still less than the other developed cane growing countries of the world. This is mainly caused due to the fact that our farmer does not have bigger options regarding high yielding and high sucrose varieties as well as vitality of the use of chemical fertilizers for producing high cane and sugar yielding varieties. Generally, our soils are deficient in essentially required nutrient elements and soil deficiency is removed by different means. Sugarcane being high delta crop requires a plenty of chemical fertilizers for obtaining higher production. There are a number of factors to consider when deciding on the types of fertilizers, amounts and methods of application. Some of the factors to consider such as: leaching potential, fertilizer release rate, effect on soil pH, nutrient mobility in the soil, cane varieties used, ratoon or plant crop and cost per unit nutrient. Nitrogen (N) is necessary for vigorous vegetative growth. However, if applied in excess, N can slow down the ripening process, especially under wet conditions. It is recommended that N be applied in the form of urea at 130 kg N/ha. Ammonium sulphate should be avoided because of its acidifying effect. It is important that the urea is covered. In case of plant cane, urea should be placed in bands parallel with the rows of setts and roughly five centimeters from them. The second split (half the amount) should be applied four months after planting for plant crop, and three months after harvesting for ratoon crop (the first split having been applied soon after harvesting). All nitrogen must be applied five months before the cane is harvested. If the application is too heavy or unduly delayed, the sucrose content of the juice can be depressed. Phosphorus is especially important for cane growth. Deficiencies retard the development of the root system (Hunsigi, 2003). Phosphorus is applied as single super phosphate (SSP) or triple super-phosphate (TSP) at a rate of 100 kg P205/ha. It is applied at the time of planting in case of plant crops or soon after harvesting in the case of ratoon crops. Phosphorus should be placed close to the plant because of its low mobility in the soil. Moderate levels of potassium (K) are available in the soil but it is still necessary to apply more. Apart from its well-known general functions in plant growth, K plays an important role in sugarcane production by counteracting the effects of N on the sucrose content of the cane juice. It must be available, therefore, in adequate amounts. There is no risk of over fertilizing, as high levels of K have no detrimental effect on the crop and contribute to the K reservoir in the soil. Potassium chloride (muriate of potash) should be applied to supply 80 kg K/ha. Potassium can be applied on its own or in combination with other fertilizers. As there is no need for special placement, the cheapest method of application should be used (Hunsigi, 2003). Keeping in view the importance of NPK fertilizers in sugarcane production, a study was carried out to see the effect of different NPK levels on quantity and quality parameters of sugarcane variety gulabi-95 under agro-ecological conditions of Tandojam.

MATERIALS AND METHODS

The experiment was laid out in a four-replicated randomized complete block design having net sub-plot size of 13m x 5m (65 m^2). Sugarcane is a deep-rooted crop and keeping this in mind a well-worked friable fully pulverized seedbed was prepared. The experimental land was prepared well before sowing in off-season. Deep ploughing was done particularly to break the hard pan of the experimental soil. After the proper land preparation, the ridges/furrows were prepared at the distance of 100 cm. The sets were placed head to head in the furrows at 6-8 inches depth of furrow. The sowing was completed up to 10th October 2004. Forty thousand two-budded sets per acre with end-to-end arrangement were planted in single row system.

The cane seed was obtained from the crop which was not more than eight months in age (nursery seed used), upper 2/3 portion of stalk of the cane of fresh/plant sugarcane crop was used for seed purpose Seed sets were treated with Vitavax @ 120 g/100 litter water against the attack of seed borne sugarcane diseases like whip smut. The irrigation was applied at 7-10 days interval in summer (April- August) and 10-15 days interval in winter (November-March). There was still shortage of canal water; hence mostly tube well water was applied. Weeds were removed from young crop, until the crop became in such height to shed the weeds. The weeds were controlled with the use of Gezapex Combi at the rate of 1 to 1½ kg per acre within a period of 3 months after planting. Weedicide was applied in moist conditions to get good results. First light earthing was done after 3-1/2 months of planting and second after 1½ month of first earthing.

The harvesting of sugarcane crop was done when the 1/3rd leaves of the basal portion of the cane became dry and shows the tendency of dropping on the ground. Scientifically, the crop becomes mature when the brix is above 20% irrespective of any variety. The quantitative parameters of the experimental crop were measured at the field, while for the qualitative parameters the cane samples from field were brought to the laboratory. Finally the data so collected were analyzed statistically using analysis of variance, and LSD test was applied to discriminate the superiority of the means of different treatments as suggested by Gomez and Gomez (1984).

RESULTS AND DISCUSSION

Germination percentage

Germination percentage was relatively greater (53.53%) under 250-122-193 kg ha^{-1}, followed by 200-102-142 and 175-92-117 kg NPK ha^{-1}, with average germination of 53.53 and 53.09 percent, respectively. The lowest germination percentage of 51.06 was recorded from the plots received 225-112-168 kg NPK ha^{-1} (Table-1). Germination percentage was almost equal under all the NPK levels and the results indicated that there was no association of germination with NPK levels and there was a minor variation in the average values of this parameter under different NPK levels. Sarwar *et al*. (2000) reported no effect of fertilizers on the germination, while the contrast results were reported by Abbasi *et al*. (2000) who were of the experience that under conditions where no NPK applied, germination was lowest.

Cane length

Significantly maximum cane length (2.20 m) was under highest NPK level of 250-122-193 kg ha^{-1} (Table-1) followed by 225-112-168 kg and 200-102-142 kg NPK ha^{-1}, with average cane length of 2.16 m and 2.08 m, respectively. The cane length was significantly minimum

(1.43 m), when the crop was left untreated (control). On the other hand, the crop growth was checked when no fertilizer was applied, and the plants could not receive required quantities of the NPK to execute the growth. Similar results have been reported by Mathew *et al*. (2003), Alexander and Mathew (2003) and Khandagave (2003), who were of the decisive opinion that higher NPK levels caused the sugarcane plants to grow taller.

Cane girth

Cane girth was significantly maximum (2.49 cm) equally under NPK levels of 250-122-193 and 225-112-168 kg ha^{-1}, followed by 200-102-142 kg and 175-92-117 kg NPK ha^{-1}, with cane girth of 2.26 cm and 2.19 cm, respectively. The crop that received no fertilizer (control) produced significantly minimum cane girth of 1.88 cm (Table-1). Cane girth was significantly maximum under NPK levels, but the differences were statistically non-significant ($P>0.05$) when two higher levels; 250-122-193 and 225-112-168 kg ha^{-1} were compared. However, 225-112-168 kg NPK ha^{-1} proved to have potential as an economical level regarding cane girth. It was further observed that each increment in the NPK level improved cane girth and the differences were highly significant when treatment means were compared with control. Mahboob *et al*. (2000) reported an optimum NPK level of 250-100-100 kg ha^{-1} for higher cane girth.

Number of tillers per stool

The number of tillers per stool was significantly maximum (6.58) under highest NPK level of 250-122-193 kg ha^{-1}, followed by 225-112-168 kg ha^{-1} and 200-102-142 kg ha^{-1} with 6.35 and 5.74 tillers per stool, respectively (Table-1). The minimum number of tillers per stool (4.30) was recorded from the plots received zero fertilizer (control). Number of tillers per stool were also affected significantly by different NPK fertilizer levels ($P<0.01$) tillers per stool were significantly maximum under highest NPK level. The comparison of the treatments showed that the situation was much in similarity to cane girth and differences were statistically non-significant ($P>0.05$) when 250-122-193 and 225-112-168 kg $ha^{-}1$ or 200-102-142 kg and 175-92-117 kg NPK ha^{-1} were compared. Similar results for have also been reported by Singh *et* al. (2001), Abbasi *et al*. (2000) and Sarwar *et al*. (2000) who reported better tillering under higher NPK levels of 112-112-112 kg ha^{-1}.

Weight of 10 canes

Significantly highest 10 canes weight (14.20 kg) was under highest NPK level of 250-122-193 kg ha^{-1}, followed by 225-112-168 kg ha^{-1} and 200-102-142 kg ha^{-1} with average 10 canes weights of 13.95 kg and 12.54 kg, respectively (Table-1), and the minimum 10 canes weight of 9.04 kg was recorded from the plots received no fertilizer (control). The weight of 10 canes was influenced highly significantly ($P<0.01$) due to different NPK levels and it was significantly highest under highest NPK level of 250-122-193 kg ha^{-1}. There was a linear trend of effectiveness and each increased NPK level increased the weight of 10 canes significantly. However, the increase in 10 canes was not economical when NPK rates increased beyond 225-112-168 kg ha^{-1}, because the differences between two higher levels were statistically non-significant. Sarwar *et al*. (2000) have reported results similar to the present investigation under 112-112-112 kg NPK ha^{-1} and Mahboob *et al*. (2000) obtained somewhat similarity in results under 250-100-100 kg NPK ha^{-1}.

Cane yield per hectare

Similarly, cane yield was significantly highest (115.264 t ha^{-1}) under 250-122-193 kg ha^{-1}, followed by 225-112-168 kg ha^{-1} and 200-102-142 kg ha^{-1} with average cane yield of 113.461 and 98.46 t ha^{-1}, respectively (Table-1). The minimum cane yield of 39.858 t ha^{-1} 9.04 kg was recorded from the plots received no fertilizer (control). Mahboob *et al.* (2000), Sarwar *et al*. (2000), Singh *et al*. (2001), Abbasi *et* al. (2002), Ali *et* al. (2002), Jadhav *et* al. (2002), More and Shande (2002) and Mathew *et al*. (2003) have also reported comparable results to those of the present investigation. They all were of the consolidated experience that sugarcane needed high fertilizer doses and lower levels or no fertilizer will cause lower yields even crop failure.

Brix content

Brix was significantly superior (22.03 %) under highest NPK level of 250-122-193 kg ha^{-1}, followed by 225-112-168 kg ha^{-1} and 200-102-142 kg ha^{-1} with average brix of 21.74 and 19.79 percent, respectively and the minimum (17.31 %) was recorded in control (Table-1). Brix percentage was also significantly affected under NPK levels and it was superior under highest NPK level of 250-122-193 kg ha^{-1} and straight effect of increasing NPK rates was recorded on this character. However, this increase in brix content was not so economical if NPK exceeded 225-112-168 kg ha^{-1}. Thus highest NPK level of 250-122-193 kg ha^{-1} was considered as the less economical as compared to that of 225-112-168 kg NPK ha^{-1} level. These results are in concurrence to those Singh *et al*. (2001), Abbasi *et al*. (2002) and Mathew *et al*. (2003), who reported significant influence of NPK fertilizers on brix percentage.

Sugar recovery

Sugar recovery was significantly higher (10.72 %) in highest NPK level of 250-122-193 kg ha^{-1}, followed by 225-112-168 kg ha^{-1} and 200-102-142 kg ha^{-1} with average sugar recovery of 10.66 and 9.67 percent, respectively (Table-1). The fertilizer rate of 175-92-117 kg NPK ha^{-1} produced sugar recovery of 9.16 percent and it was minimum (8.25 %) in control. In case of sugar recovery, there was a linear influence on sugar recovery in cane juice under different NPK levels and each increased NPK level significantly improved the sugar recovery in cane juice. However, the sugar recovery was not significantly increased when NPK exceeded 225-112-168 kg ha^{-1}.

CONCLUSIONS

After going through the results in detail, it was concluded that for all the growth, cane yield and sugar recovery contributing parameters, 250-122-193 kg NPK ha^{-1} level was better than other NPK levels. However, the differences between 250-122-193kg and 225-112-168kg NPK ha^{-1} levels were non-significant. Thus 225-112-168kg NPK ha^{-1} fertilizer level was considered as an optimum level for economical sugarcane production.

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Table-1 Effect of different NPK fertilizer levels on the growth, cane yields and sugar recovery of sugarcane variety Gulabi-95

NPK levels (kg ha^{-1})	Germi-nation (%)	Cane length (cm)	Cane girth (cm)	Tillers $stool^{-1}$	Weight of 10 canes (kg)	Cane yield (tons/ha)	Brix content (%)	Sugar Rec. (%)
Control	53.00	1.43 c	1.88 c	4.30 c	9.04 d	39.858 d	17.31 d	8.25 d
175-92-117	53.09	1.86 b	2.19 b	5.20 b	10.96 c	92.399 c	18.68 c	9.16 c
200-102-142	53.52	2.08 a	2.26 b	5.74 b	12.54 b	98.468 b	19.79 b	9.67 b
225-112-168	51.06	2.16 a	2.49 a	6.35 a	13.95 a	113.46 a	21.74 a	10.66 a
250-122-193	53.53	2.20 a	2.49 a	6.58 a	14.20 a	115.26 a	22.03 a	10.72 a
S.E.±	2.357	0.0341	2.3570	0.1629	0.2197	0.5999	0.1839	0.0951
LSD 0.05	-	0.1143	-	0.5379	0.7241	1.978	0.6064	0.3129
LSD 0.01	-	0.1558	-	0.7379	0.9877	2.699	0.8271	0.4268
CV %	9.97	3.91	9.97	6.47	4.05	1.46	2.07	2.19

SUGARCANE VARIETAL ADOPTION IN THE CENTRAL PUNJAB

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ABSTRACT

As result of rapid increase in number of Sugar Mills, the area under sugarcane did not increased so much to fulfil the Sugar Mills requirements and most of the mills are running under capacity or closed. The overall area under sugarcane has decreased in recent survey as compared to 1996 and 2000 surveys. The survey results shows that non-recommended sugarcane varieties (Co-1148and SPF-238) are the dominant varieties in the area and still occupied about 28 percent of the total sugarcane area in the central Punjab. The sugarcane varietal shift from non-recommended (low in sugar recovery) to recommended varieties is encouraging in the study area. Moreover, the percent area under non-recommended variety Co-1148 has decreased in the area as compared to previous surveys (1993, 1996 & 2000). These results have serious long-term implications for researcher, Sugar Mills and extension agents.

INTRODUCTION

Sugarcane being an important cash crop of Pakistan serves as a major raw material for the production of white sugar, brown sugar, shakar and gur. Besides sugar production, sugarcane produces numerous valuable byproducts like, alcohol used by pharmaceutical industry, ethanol used as a fuel, bagasse used for paper, and chip board manufacturing and press mud used as a rich source of organic matter and nutrients for crop production (Raja, 2006). Its share in value added of agriculture and GDP are 3.4 percent and 0.7 percent, respectively (GOP, 2006).

Being the major contributor in sugarcane area and production, Punjab shared more than 66 percent in area and about 70 percent in production (GOP, 2006). The average sugarcane yield of Punjab is 51.3 tonnes per hectare, which is higher than the national average yields i.e. 48.9 tonnes per hectare during the year 2004-05 (GOP, 2006). Unfortunately, average yield of sugarcane and sugar recovery of Pakistan is lower than the world average (Raja, 2006). The sugar recovery of Pakistan was around 8.5 percent (Imam, 2001).

Development of new varieties with the required characteristics (higher yield and sugar recovery) can be an important mean for enhancing crop productivity in the country. Although the breeders of agricultural research institutes claims that their new varieties of sugarcane are better in yield and sugar recovery, but the adoption of these new varieties is discouraging in the Punjab. According to Bashir, et.al (2001) about 77 percent of the total sugarcane area is being planted under non-recommended varieties especially Co-1148 (about 66 percent) in the central Punjab. The present paper was planned to generate the information of adoption of recommended varieties in the central Punjab.

Objectives of the Study

To assess the extent of adoption of different sugarcane varieties in the central Punjab.
To see the over time change in sugarcane varietal composition.

Research Methodology

Overall, 150 sugarcane growers were randomly selected from the top three sugarcane growing districts, Faisalabad, T.T. Singh and Jhang of the central the Punjab as sample of the study area (Table 1).

Table-1 Distribution of the sampled sugarcane grower by farm size and district

Districts	Farm size groups			
	Small (<12.5 Ac)	Medium (12.5-25 Ac)	Large (.25 Ac)	All
Jhang	9 (18.0)	11 (22.0)	30 (60.0)	50 (100.0)
T.T. Singh	15 (30.0)	15 (30.0)	20 (40.0)	50 (100.0)
Faisalabad	23 (46.0)	15 (30.0)	12 (24.0)	50 (100.0)
All Area	47 (31.3)	41 (27.3)	62 (41.4)	150 (100.0)

Note: The figures within the brackets are percentages.

For the purpose of data analysis, sugarcane growers were classified in three categories i.e. small, medium and large. The sugarcane growers with an operational holding less than 12.5 acres were placed under the small farmers category, whereas, the farmers having operational land holding between 12.5 and 25 acres were placed under medium farmers. The farmers who have more than 25 acres of farming were classified as large farmers. Majority of the sample farmers (41.4 %) were large farmers followed by small farmers. The inter district comparison reveals that the percent of large farmers was relatively higher in Jhang Dist. as compared to T. T. Singh and Faisalabad (Table-1).

RESULTS AND DISCUSSIONS

Farm Size and Area under Sugarcane

Overall, the farmers allocated more than one third (28.96 %) of the total operational area to sugarcane crop. The farm size comparison reveals that large farmers allocated relatively less area to sugarcane crop as compared to small and medium farmers. The farmers of the Faisalabad district allocated more area to sugarcane as compared to Toba Tek Singh and Jhang (Table 2). This increase in sugarcane area may be due increase in cane prices and low yield of cotton crop in the area.

Table-2 Average farm size, sugarcane area and percent area under sugarcane

Farm size/districts	Average farm size	Average sugarcane area	Percent farm area under sugarcane
Farm Size			
Small	8.64	3.23	37.38
Medium	19.22	7.61	39.59
Large	67.03	17.51	26.12
District			
Jhang	56.72	13.58	23.94
T.T. Singh	30.53	10.29	33.70
Faisalabad	19.76	7.13	36.64
All Farms/Districts	35.67	10.33	28.96

Sugarcane Varieties Planted on Sample Farms

Majority of the farmers (31.33 %) planted four or more varieties on their farms. The inter farm size comparison showed that percentage of farmers planted four or more varieties was significantly higher among large farmers as compared with medium and large farmers. The district comparison revealed that the percentage of farmers planted four or more number of sugarcane varieties on their farm was slightly higher in Toba Tek Singh district as compared with other two districts in the study area.

Table-3 Number of Sugarcane Varieties Planted on Sample Farm

Farm size/districts	Number of sugarcane varieties planted				Sig.
	One	Two	Three	Four and above	
Farm size groups	**Percent farmers**				
Small	25.53	42.55	21.28	10.64	0.000
Medium	12.20	31.71	34.15	21.95	
Large	9.68	17.74	19.35	53.23	
District	**Percent Farmers**				
Jhang	10.00	32.00	30.00	28.00	0.743
T.T. Singh	18.00	30.00	18.00	34.00	
Faisalabad	18.00	26.00	24.00	32.00	
All Farms/Districts	15.33	29.33	24.00	31.33	

Adoption of Recommended Sugarcane Varieties

Overall the adoption of recommended sugarcane varietal was encouraging in the area keeping in view the previous situation. Co-1148 (15.44 %), SPSG-79 (12.36 %), SPF-238 (12.16 %), Coj-84 (8.60 %), HSF-240 (8.53 %) and SPF-237 (8.52 %) were the main sugarcane varieties grown by the farmers on their farms. The inter farm size comparison revealed that the percent area under recommended varieties such as Coj-84, HSF-240 and SPF-237 was relatively higher on large farms as compared with small and medium farmers (Table 4). Similar trend was found among farmers of district Jhang for allocation of area under newly recommended varieties as compared with other sampled district (Table 5). SPF-238, HSF-240 (8.53 %) and SPF-237 mainly replaced Co-1148 on the sample farms. Although the area under Co-1148 has declined from the previous year but still this non-recommended variety has share of more than 15 percent of the total sugarcane area on the sampled farms. This slow pace of varietal change from non-recommended variety Co-1148 to recommended varieties may be due to good ratooning that can prolong up to 4 to 6 years. Thus farmers have preferences for this variety to save sowing costs, which is the major cost in sugarcane production

Table-4 Percent Area under Different Sugarcane Varieties by Farm Size

Sugarcane varieties	Farm size groups			
	Small	Medium	Large	All
CP 43-33	2.63	4.97	3.18	3.48
CP 72-2086	0.00	0.00	0.55	0.39
CP 77-400	3.95	2.40	8.10	6.55
SPF-213	0.00	0.48	1.20	0.94
Coj-84	7.24	2.72	10.48	8.60
HSF-240	2.30	6.89	9.88	8.53
SPF-234	9.21	8.81	3.20	4.92
SPF-237	3.45	7.69	9.46	8.52
SPSG-79	20.07	7.69	12.62	12.36
SPSG-26	2.63	3.04	3.22	3.13
Co-1148	21.22	31.57	9.99	15.44
SPF-238	5.76	9.13	13.93	12.16
SPSG-394	0.66	0.80	0.46	0.55
NSG-555	0.00	0.00	0.78	0.55
SPF-241	10.86	9.29	1.93	4.29
COL-54	0.16	0.00	0.60	0.44
Triton	3.95	0.00	0.09	0.45
Other	5.92	4.49	10.32	8.71

Table-5 Percent area under different sugarcane varieties by sampled districts

	Sampled districts			
Sugarcane varieties	Jhang	T.T. Singh	Faisalabad	All
CP 43-33	0.88	9.33	0.00	3.48
CP 72-2086	0.29	0.78	0.00	0.39
CP 77-400	9.21	3.30	6.17	6.55
SPF-213	1.33	1.07	0.00	0.94
Coj-84	11.20	9.57	2.24	8.60
HSF-240	8.99	6.75	10.24	8.53
SPF-234	0.59	6.37	11.08	4.92
SPF-237	10.61	7.82	5.54	8.52
SPSG-79	16.76	10.79	6.24	12.36
SPSG-26	3.98	3.79	0.56	3.13
Co-1148	6.85	18.71	27.07	15.44
SPF-238	15.99	11.47	5.89	12.16
SPSG-394	0.15	1.46	0.00	0.55
NSG-555	1.25	0.00	0.00	0.55
SPF-241	0.74	1.85	14.59	4.29
COL-54	0.00	0.00	1.89	0.44
Triton	0.00	0.15	1.75	0.45
Other	11.20	6.80	6.73	8.71

Overtime Change in Sugarcane Varietal Comparison

The mixed cropping zone of the irrigated Punjab is the major contributor in term of area under sugarcane crop. The comparison of the results of sugarcane varietal adoption surveys conducted in sample districts are presented in Table 6.

Table-6 Comparison of percent area under different sugarcane varieties

Sugarcane Varieties	Survey Year			
	1993	1996	2000	2004
Recommended Varieties				
CP 72-2086	--	--	--	0.39
SPSG-26	--	--	3.7	3.13
CP-43-33	--	--	1.8	3.48
CP-77-400	--	--	1.5	6.55
Coj-84	--	--	13.9	8.60
L-118	11.4	--	--	--
SPF-213	--	--	--	0.94
HSF-240	--	--	--	8.53
SPF-234	--	--	--	4.92
SPF-237	--	--	--	8.52
NSG-555**	--	--	--	0.55
SPF-241**	--	--	--	4.29
Non-recommended Varieties				
Co-1148	54.8	93.4	65.6	15.44
SPSG-79	--	--	2.4*	12.36
SPF-238	--	--	--	12.16
SPSG-394	--	--	---	0.55
COL-54	7.2*	0.4*	--	0.44
Co-975	--	3.9	--	--
BL-4	9.1*	1.7*	1.4	--
Tritran	16.6*	--	3.3	0.45
Other	0.9	0.4	6.4	8.71

Source: Bashir et. al (1997 & 2000)

* These varieties were recommended in respective survey years

** New varieties but still not recommended for cultivation

The comparison shows that proportion of farm area allocated to sugarcane crop increased from 20.2 percent in 1993 to 36.6 percent in 1996. This increase may be due to the rapid increase in the sugar mills from 24 in 1990-91 to 37 in 1995-96. The percent area under sugarcane in the varietal survey conduct in the year 2000 was almost same as compared to 1996 (Bashir *et. al*. 2000). Shortage of canal water for irrigation, sugar mills management behaviour for purchase and payment of sugarcane and increase in cost of inputs were the main causes for decline in sugarcane area. The percent farm area under sugarcane in the year 2004 had declined from 36.3 percent to 28.96 percent. However, the area under recommended varieties has increased from 23.3 percent in 2000 to 49.89 percent in 2004 (Tabe-7).

Table-7 Overtime change in sugarcane varietal adoption

Comparison Items	Survey Year			
	1993	1996	2000	2004
Percent area under sugarcane	20.2	36.6	36.3	28.96
Percent area under recommended varieties	44.3	2.1	23.3	49.89
Percent area under Co-1148	54.8	93.4	65.6	15.44
Percent farmer planted only one variety	78.7	88.5	56.7	15.33

CONCLUSIONS AND RECOMMENDATIONS

The adoption of recommended varieties on the sampled farms was encouraging in the area in the recent surveys. The sugarcane variety Co-1148 was the main variety in the area and still occupied more than 15 percent of the total sugarcane area. The varietal shift from non-recommended (low in sugar recovery) to recommended varieties was slow because according to farmer perceptions Co-1148 and SPF-238 has advantage over new varieties in weight and ratooning that can prolong up to 4 to 6 years and saved farmers sowing costs as compared to new varieties.

RECOMMENDATIONS

Most of the Sugar Mills management did not take appropriate measures for the seed multiplication and distribution of high sugar recovery recommended varieties among sugarcane growers. The price of cane should base on sucrose contents rather than the cane weight. In other words price incentive should be given to high sugar content varieties, which will encourage the farmers for planting new varieties. The sugar mills in their surrounding areas should launch the promotion and distribution of seed of high sugar contents varieties. It is suggested that there is a need for conducting varietal adoption survey regularly for generating information for sugarcane breeders, sugar mills management, extensions and policy makers for promotion of new varieties having high sugar contents.

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